DENNING HABITAT AND DIET OF THE SWIFT FOX IN WESTERN SOUTH DAKOTA

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ABSTRACT.—Swift fox (*Vulpes velox*) were investigated in western South Dakota to determine food habits and denning site characteristics. Over a three-year period food habits consisted of mammals (49%), followed by insects (27%), plants (13%), and birds (6%). Dens were located near hilltops within two habitat types, shortgrass and midgrass prairie; each type is characterized by differing plant species. Soil type was not a selective factor for den sites of swift fox. Management considerations for enhancing swift fox populations are presented.

The swift fox (*Vulpes velox*), a threatened species in South Dakota, was reported to be abundant on the Great Plains when settlers arrived (Egoscue 1979). With the increasing settlement of the northern High Plains, populations of swift fox declined, and by 1900 the species was rare in its northern range (Beck 1958, Soper 1964, Egoscue 1979). In South Dakota swift fox sightings were not reported between 1914 and 1966 (Hillman and Sharps 1978). The decline of the swift fox population has been attributed to the loss of natural prairie habitat, predator and rodent control programs, excessive trapping, and hunting (Egoscue 1979).

Since 1975 a small population of swift fox has been present in South Dakota, which provided an opportunity for observation of food habits and habitat characteristics around denning sites (Hillman and Sharps 1978). Other investigations on food habits and habitat of denning sites have been reported by Kilgore (1969) in Oklahoma and Cutter (1958a, 1958b) in Texas. However, very little information is available on swift fox food habits and den site characteristics within the northern range of its distribution.

The objectives of this study were to determine food habits of the swift fox and habitat characteristics at denning sites in western South Dakota.

STUDY AREA

The study areas selected were known to have viable swift fox populations. The first was located on the Pine Ridge Indian Reservation, Shannon County, South Dakota, approximately 23 km north of Oglala. This area is a broad flood plain with gently sloping to undulating upland prairie, bordered by the White River to the north. Badland outcroppings, which are found throughout the Pine Ridge area, are typified by bare soil; soil types are primarily clayey to sandy-clay-loam. Annual precipitation averages 41 cm, with an annual snowfall of 79 cm. Dominant vegetation consists of buffalograss (*Buchloe dactyloides*), needleleaf sedge (*Carex eleocharis*), blue grama (*Bouteloua gracilis*), and western wheatgrass (*Agropyron smithii*). Livestock graze throughout the area.

The second study area was located in Haakon County, 40 km north of Philip. This area is characterized by gently undulating hills with numerous livestock watering ponds. The soil type is primarily clay to clay-loam. Annual precipitation averages 43 cm, with an annual snowfall of 30 cm. Dominant vegetation of this area includes western wheatgrass, buffalograss, and blue grama. Livestock graze the area and, in addition, there is some farming.

METHODS

Swift fox were located by spotlighting within each of the study areas. On the Pine Ridge study site, three natal dens were studied during 1977 and 1978 and four in 1979. One natal den was studied north of Philip during 1978 and 1979.

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TABLE 1. Major plant species characterizing den sites of swift fox at two study areas (frequency of occurrence ≥ 5%) in South Dakota.

Species	% Frequency of occurrence	
	Pine Ridge	Philip
GRASS AND GRASSLIKE		
Western wheatgrass (*Agropyron smithii*)	32	87
Little bluestem (*Schizachyrium scoparium*)	11	
Red threeawn (*Aristida longiseta*)	13	
Blue grama (*Bouteloua gracilis*)	45	62
Japanese brome (*Bromus japonicus*)	6	
Cheatgrass brome (*Bromus tectorum*)	14	
Buffalograss (*Buchloe dactyloides*)	70	64
Sixweeks fescue (*Vulpia octoflora*)	8	
Needleandthread (*Stipa comata*)	24	5
Needleleaf sedge (*Carex eleocharis*)	46	25
FORBS		
Onion (*Allium* spp.)		12
Pinnate tansy mustard (*Descurania pinnata*)		13
Curlycup gumweed (*Grindelia squarrosa*)		20
Prairie sunflower (*Helianthus petiolaris*)		5
Stickseed (*Lappula redowskii*)		17
Prairie pepperweed (*Lepidium densiflorum*)		11
Virginia pepperweed (*Lepidium virginicum*)		25
Dotted gayfeather (*Liatris punctata*)		8
Rush skeletonplant (*Lygodesmia juncea*)	11	
Black medic (*Medicago lupilina*)		8
Yellow sweetclover (*Melilotus officinalis*)		13
Musineon (*Musineon divaricatum*)		5
Hoods phlox (*Phlox hoodii*)		7
Scarlet globemallow (*Sphaeralcea coccinea*)	19	10
Field pennycress (*Thlaspi arvense*)		9
Vetch (*Vicia* spp.)		6
SHRUBS		
Silky wormwood (*Artemisia* dracunculoides)	5	

Vegetation analyses were conducted during June and early September of 1978 and 1979. Frequency of occurrence was estimated along two 30m line transects located at each den site, and estimates were made by reading 30 2 × 5 dm quadrats systematically spaced at 1 m intervals along each of the transects (Daubenmire 1959). Data were summarized by transect and averaged over two years for both study areas. In addition, soils were measured at each den site for texture by the hydrometer method (Brady 1974).

Swift fox scats were collected weekly from adults and young pups at each den site from May through September of each year. Each collection consisted of 1 to 30 scats from each den site. Each sample was placed in a fine mesh nylon bag, washed in low-suds detergent, and rinsed. The bags and contents were then tumbled dry in a clothes dryer, which aided in separation of the prey material in the scats. The hair, feathers, bone, insects, plan material, and other items were used to identif prey remains in the scats (Johnson and Hanse 1977). Analyses of the scat materials were base on the 100-point frame method (Chamrad an Box 1964). Scat materials from the Philip are were combined with those from the Pine Ridg area because of small sample size. All frequenc of occurrence values were averaged for each yea and expressed as percent relative frequency b the following formula:

$$\text{Relative frequency} = \frac{\text{Frequency of occurrence of food item}}{\text{Total frequency of occurrence for all food items}} \times 10$$

Kulcynski's similarity index (Oosting 1956 compared swift fox diets among years. Spear man's rank-order correlation (r_s) and chi square contingency tables were used for die and vegetation analyses.

TABLE 2. Dietary composition (% relative frequency) of swift fox scats collected from two sites in South Dakota from May through September over a three-year period.

Item	Years			Average
	1977	1978	1979	
MAMMALS				
Sciuridae	43.3	25.5	18.5	29.1
Leporidae	4.9	7.0	0	4.0
Muridae (Cricitidae)	5.8	16.1	6.2	9.4
Heteromyidae	2.9	7.2	2.6	4.2
Geomyidae	0.5	3.1	0.6	1.4
Insectivora	0	0.6	0	0.2
Mustelidae	0	2.0	0	0.7
Bovidae	0	0.2	0	0.1
BIRDS	5.8	2.9	0.9	6.2
INSECTS	22.3	19.3	39.0	26.9
PLANT	10.8	11.5	16.4	12.9
OTHER	4.3	4.4	6.8	5.2

RESULTS

Plants and Soils of Denning Sites

Vegetation associated with the denning sites of swift fox at Pine Ridge was much different than at the Philip site (Table 1). At Pine Ridge major grasses and grasslike plants in decreasing order included buffalograss, needleleaf sedge, blue grama, and western wheatgrass. A total of 17 grass and grasslike species was found on this area. Common forbs were scarlet globemallow (*Sphaeralcea coccinea*) and rush skeletonplant (*Lygodesmia juncea*). Thirty-nine forb species were recorded. The only shrub was silky wormword (*Artemisia dracunculoides*).

Vegetation associated with dens at Philip was less diverse than at Pine Ridge, with 43 and 57 species, respectively. However, the plants were more frequently represented at Philip (Table 1). Major grasses and grasslike plants were western wheatgrass, buffalograss, blue grama, and needle leaf sedge. A total of 10 grass species were observed. Forbs included 29 species with dominant ones being prairie pepperweed (*Lepidium virginicum*), curlycup gumweed (*Grindelia squarrosa*), stickseed (*Lappula redowskii*), and yellow sweetclover (*Melilotus officinalis*). The four shrub species present in the Philip area were silky wormwood, silver sagebrush (*A. cana*), sand sagebrush (*A. filifolia*), and fringed sagebrush (*A. frigida*).

Relative frequency of grasses and grasslike plants was 76% of the vegetation composition at Pine Ridge and 55% at Philip; however, forbs were lower, with 23% and 43% at Pine Ridge and Philip, respectively. Shrubs were low at both sites, with only 1% and 2% of the composition.

Soils were highly variable among denning sites. Soils at Pine Ridge were loam, clay-loam, and sandy-clay-loam. At Philip, soils were mostly clay.

Scat Analyses

The most frequent items in swift fox scats were mammals (49%), followed by insects (27%), plants (13%), and birds (6%) (Table 2). Swift fox dietary habits were different ($P < 0.05$) among the three years studied.

Average similarities varied among years when swift fox scat contents were compared. Scat contents for 1977 and 1978 were 54% similar. Scat contents were 72% similar between 1977 and 1979. However, 1978 and 1979 scats were only 41% similar in prey remains. This shows that food items were consumed in relatively different proportions among the years (Table 2).

Spearman's rank order correlations (r_s) among years were significant ($P < 0.01$), ranging from 0.76 to 0.89. This indicates that the food items found in the scats during the three years were consumed in same relative rankings.

The mammal species identified in the scats of swift fox included black-tailed prairie dog (*Cynomys ludovicianus*), hispid pocket

mouse (*Perognathus hispidus*), northern pocket gopher (*Thomomys talpoides*), deer mouse (*Peromyscus maniculatus*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), northern grasshopper mouse (*Onychomys leucogaster*), western harvest mouse (*Reithrodontomys megalotis*), eastern cottontail (*Sylvilagus floridanus*), white-tailed jackrabbit (*Lepus townsendi*), voles (*Microtus* spp.), shrews (*Sorex* spp.), and undetermined Mustelidae. Cattle remains originating from carrion were also found in the scats.

Birds present in the scats included: Western Meadowlark (*Sturnella neglecta*), Chestnut-collared Longspur (*Calcarius ornatus*), Mourning Dove (*Zenaidura macroura*), Horned Larks (*Eremophila alpestris*), Lark Bunting (*Calamospiza melanocorys*), and Red-winged Blackbirds (*Agelaius phoeniceus*). Insects included were Orthoptera (grasshoppers) and Coleoptera (beetles). Plants included grass and cactus (*Opuntia* spp.) fruit.

DISCUSSION

Swift fox dens were generally located on or near the tops of hills on the undulating prairie in South Dakota, in pastures receiving moderate to heavy use by cattle. Cutter (1958a) reported on 25 dens in Texas, which were located within open sparsely vegetated areas on sloping plains, hilltops, or other well-drained areas; 19 of the dens found by Cutter were in heavily grazed pastures, and the 6 others in plowed fields and fence rows. In Oklahoma Kilgore (1969) found approximately 50% of swift fox dens in plowed fields and the others in shortgrass pastures. In our study swift fox dens were found in two habitat types, shortgrass and a midgrass prairie. Thus it has been shown that swift fox are able to select denning sites within various habitat types ranging from plowed fields, and fence rows, to a midgrass prairie having moderate livestock utilization.

Swift fox were not selecting dens within specific soil types in this study. Dens were located in four soil types in western South Dakota, and Kilgore (1969) also stated that dens were present on four soil types in Oklahoma. Most swift fox dens in our study were located near the tops of hills, which provides adequate drainage. Swift fox periodically clean their dens and pull soil from the den entrance, often in one direction indicating that the soil has a loose structure (Hillman and Sharps 1978). In our study dens were generally exposed in an easterly direction, and the natal dens had an average of four openings per den complex.

Prairie dogs, grasshoppers and beetles were the major components of the swift fox diet. Mammals provided 49% of the diet and insects 27%. In Texas Cutter (1958b) found that invertebrates provided 34% of the swift fox diet, while mammals provided 34%. Cottontails (*Sylvilagus* spp.) provided over 50% of the food consumed in the early spring by swift fox in Oklahoma (Kilgore 1969). Kilgore found that mammals, other than lagomorphs accounted for 82% of the fox diet during the autumn. Insects were also abundant in fox diets. Generally, from these studies and ours, it can be concluded that mammals and insects make up the major proportion of foods eaten by swift fox. Birds and plant material are less commonly consumed.

Human activities present the greatest threat to the swift fox in South Dakota (Hillman and Sharps 1978). Swift fox are easily trapped, shot, or poisoned and many times become victims of control efforts directed toward rodents and other predators. Predator and rodent control programs are being conducted which may impact swift fox in South Dakota. Bait treated with zinc phosphide has been used in western South Dakota and extensively on the Pine Ridge Indian Reservation for prairie dog control, but its use is reported to present only a minimal hazard to the swift fox (Schitoskey 1975). Compound 1080, developed for carnivores, has been released for predator and rodent control, which may result in poisoning of swift fox when application is within areas of swift fox residence. Compound 1080, used for prairie dog control, may have a secondary poisoning effect on the swift fox, since prairie dogs are a major component of the foxes' diet. To enhance the populations of swift fox, we need an accurate assessment of the swift fox distribution, especially on areas where predator and rodent control programs are being initiated. Our study shows that swift fox are not restricted to one habitat type, but several. An understand-

ing of swift fox habitat requirements, i.e., food, water, cover, and tolerance to human disturbance, is essential to the successful management of the swift fox.

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